Book Reviews

Joseph L. Horner, Book Reviews Editor

Send books for review to the Managing Editor, Optical Engineering, P.O. Box 10, Bellingham, WA 98227-0010. Since there is not space to review all books received, the Book Reviews Editor will use his discretion in selecting those of most interest to the readership of this journal.

Laser-Induced Dynamic Gratings

H. J. Eichler, P. Günter, and D. W. Pohl (Vol. 50, Springer Series in Optical Sciences), 256 pp., illus., index, references. ISBN 0-387-15875-8. Springer-Verlag, 175 Fifth Ave., New York, NY 10010 (1986) $53.00 hardbound.

Reviewed by George C. Valley, Hughes Research Laboratories, 3011 Malibu Canyon Road, Malibu, CA 90265.

This is another useful book in the Springer Series in Optical Sciences. It contains discussions of grating formation and detection, the phenomena that can be probed with grating techniques, and a large number of applications such as real-time holography, phase conjugation, and four-wave mixing. As is often the case with multiple-author books, some subjects are treated more than once, style and notation vary from section to section (there is a useful symbol index, however, so that multiple use of the same symbol is not especially confusing), and the authors' specialties receive more comprehensive treatment than some other subjects.

In addition to the introductory and concluding chapters, the book consists of six main chapters. Chapter 2 is devoted to general properties of gratings, the relation between gratings and nonlinear optics, and typical mathematical formulations for beams and pulses. While much of this material can be found elsewhere, it is needed here for completeness, and the emphasis on tensor properties in describing the interference of pump beams with different polarizations is particularly welcome.

Chapter 3 contains a discussion of grating formation in specific nonlinear systems, including atomic states, population density in solids and liquids, semiconductors, photorefractive materials, and thermal and concentration gratings. One surprise in this chapter is the absence of a specific discussion of sodium. There is, however, a thorough listing, complete with references, of a large number of materials and interactions—enough to get a researcher started in any one of multiple areas.

Chapter 4 presents solutions to some of the most common forms of the wave equations in nonlinear optics. The cases covered include four-wave mixing, beam coupling, thick and thin gratings, and moving gratings. As is desirable in a book such as this, the emphasis is on practical expressions as opposed to lengthy analysis.

In Chap. 5 the authors turn the subject around and ask what can be learned about physical phenomena through laser-induced gratings. The major emphasis of this chapter is flow studies, including subjects such as thermal gratings, concentration gratings, and flow visualization. In addition, there are several short sections that discuss some of the subjects of Chap. 3 in terms of measuring materials properties.

A totally separate subject, real-time holography, is covered in Chap. 6. Here the emphasis is on prototype operations and devices that involve photorefractive materials. This chapter is primarily an update of the device sections of Günter's earlier review paper on photorefractive materials and contains a lot of material published in the 1982–1984 time frame. Until the forthcoming Springer-Verlag books on photorefractive materials are published (during 1987), this chapter will be useful as a start in this field.

Chapter 7 appears to be a catch-all, with brief discussions of a number of processes that do not appear to fit elsewhere in the book, including spatial hole burning in lasers, distributed-feedback lasers, beam steering, one-way viewing, optical filters, coherence measurements, and coherence peaks. The utility of these sections compared to the original papers is not completely clear.

The most valuable feature of this book is its references—nearly 600 in all. The book will be a place to look when a co-worker says, "Didn't so and so do that in the late 70s?" The book is also useful because it presents the commonly used expressions, not the lengthy analytical results that defy comparison to experiments. The book's 123 figures—mostly experimental setups or devices and results—are also valuable for easy reference or for starting investigation in a new subfield.

The major weakness in the book is an apparent need for additional editing and polishing. For instance, in Chap. 2 the reader finds a discussion of gratings, in Chap. 4 he finds the theory of diffraction and four-wave mixing, and in Chap. 6 he finds an introduction to holography. Since these areas are all interrelated, the book would have been better organized and more useful if these sections had been better tied together or integrated into one chapter. At several points in the book, sections within chapters follow with no real logical tie. Finally, the book contains typographical and other minor errors that indicate a lack of sufficient editing.

Nonlinear Optics and Quantum Electronics

Max Schubert and Bernd Wilhelmi (Wiley Series in Pure and Applied Optics), xviii + 726 pp., illus., index, references, appendixes. ISBN 0-471-08807-2. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158 (1986) $59.95 hardbound.

Reviewed by David R. Andersen, University of Iowa, Department of Electrical and Computer Engineering, Iowa City, IA 52242.

As its title suggests, *Nonlinear Optics and Quantum Electronics* is concerned with the two important and rapidly growing fields. It is divided into two broad parts: Part I, General Concepts and Methods of Nonlinear Optics, and Part II, Effects and Processes of Nonlinear Optics. Part I is composed of six chapters and is intended to be a general introduction to nonlinear optical processes. Part II contains eight chapters and is devoted to the application of the concepts discussed in the first part. In addition, there is an Appendix that surveys the ideas of quantization of both matter and the electromagnetic field. References specific to the material contained in each chapter are listed at the end of the chapter; a set of general references is also included at the end of the book. Finally, a section on Notation and Symbols was included immediately preceding the text. This section enhances the book's value as a reference tool, as all notation is spelled out at the beginning, eliminating a reader's need to dig through the book in order to clarify some nonstandard notation.

The first part of the book is a well-organized, well-written textbook covering the fundamentals of both nonlinear optics and quantum electronics in an extremely detailed fashion. Beginning with Maxwell's equations in linear, homogeneous media, the authors cover the classical description of electromagnetic fields, including an excellent section on the various orders of nonlinear susceptibility tensors, methods for quantizing the free (or sourceless) radiation fields, and interactions between matter and radiation. This latter discussion contains classical, semiclassical, and full quantum theoretical models. Single photon processes are discussed in some detail due to their widely ranging applicability.

A semiclassical description of nonlinear optics is provided next, where the field is modeled according to standard classical techniques and the matter becomes quantized. Included is the familiar two-level system in both the steady-state and time-dependent cases. Statistical and coherence properties of radiation fields are discussed. Various detection techniques are also analyzed, as are the classical and quantum correlations for various sources. Part I concludes with a chapter describing optical generation and pulse propagation in nonlinear media. This section would serve well as a course text for an intermediate-level graduate course on quantum electronics and nonlinear optics. The organizational skills and attention to detail exhibited by the authors are well evident.

Part II will serve as a good reference on several topics actively being researched at the current time. These topics range from a general section on nonlinearities in steady-state and transient one-photon processes, including a discussion of laser field fluctuations, self-induced transparency, pulse shaping, and mode locking, to chapters on multiphoton processes, harmonic generation, stimulated Raman scattering, optical bistability, and nonlinear optical phase conjugation.

Various effects resulting from multiphoton processes are discussed in Chap. 10. Beginning with a short section on the basic phenomenon, the treatment proceeds from the transition probabilities, attenuation of electromagnetic fields, and ionization to two-photon fluorescence and lasing properties. The references associated with this chapter are not particularly recent, dating mostly from the late 60s to mid-70s. Sum and difference frequencies and harmonic generation are covered in Chap. 11. This material includes amplitude equation models, quantum interaction fundamentals, and material parameters required for obtaining the various processes—including the important but often neglected topic of phase matching—and finally the coherence properties of the resulting fields.

Stimulated Raman scattering (SRS) is the phenomenon covered in most detail in Part II. A chapter spanning 80 pages is included. Classical and quantum models of SRS by polarizable molecules, phonons and polaritons, stimulated Brillouin scattering, and spin-flip processes are all discussed. In the chapter on optical bistability, the dispersive bistability associated with a nonlinear Fabry-Perot resonator is analyzed. Also, a discussion of recent (circa 1980) experimental research results is included. Results from experiments on both sodium vapor and the semiconductor materials InSb and (Al,Ga)As are summarized. Finally, the last chapter is a brief commentary on the area of nonlinear optical phase conjugation. Mechanisms that result in phase conjugated fields are discussed, and a section on applications such as adaptive optics and resonators is included. References in this chapter are also primarily from the period 1975–1982.

Although the rapidly changing nature of research in this area precludes the presentation of a fully up-to-date picture of the field in a book of this type, this book does serve a worthwhile purpose: that of collecting in one volume many of the ideas and techniques used to pursue research in the broad areas of nonlinear optics and quantum electronics. The book is well organized, detailed, and accurate in its presentation and should be a part of any active researcher's personal library.

Books Received

CRC Handbook of Laser Science and Technology, Volume IV: Optical Materials, Part 2: Properties. Marvin J. Weber, ed., 481 pp., illus, index, references. ISBN 0-8493-3504-3 (1986) hardbound. CRC Press, Inc., 2000 Corporate Blvd. NW, Boca Raton, FL 33431. Covers materials for fundamental uses—transmission (laser windows and lenses), filtering, reflection, and polarization—and more specialized uses, involving linear electro-optic, magneto-optic, elasto-optic, and photorefractive effects and liquid crystals.

Guiding, Diffraction, and Confinement of Optical Radiation. S. Solimeno, B. Crosignani, and P. DiPorto. ISBN 0-12-654341-0. Academic Press, 6277 Sea Harbor Dr., Orlando, FL 32821. $49.95 softcover.

Light Scattering in Magnetic Solids. M. G. Cottam and D. J. Lockwood. ISBN 0-471-81701-5. John Wiley & Sons, 605 Third Ave., New York, NY 10158. $36.95 softcover.

Optical Systems for Soft X Rays. Alan G. Michette, ix+334 pp., illus., index, references. ISBN 0-306-42320-0 (1986), $55 hardbound. Plenum Press, 233 Spring St., New York, NY 10013. Discusses optical properties of systems suitable for soft x rays, plus thin-film phenomena and microlithographic processes.

Structure and Bonding in Noncrystalline Solids. George E. Walrafen and Akos G. Revesz, eds., ix+449 pp., illus., index, references. ISBN 0-306-42396-0 (1986) $75 hardbound. Plenum Press, 244 Spring St., New York, NY 10013. Based on the proceedings of the International Symposium on Structure and Bonding in Noncrystalline Solids held May 23–26, 1983, in Reston, Va., but includes chapters submitted independently of the conference.

William H. Price Scholarship in Optical Engineering

The William H. Price Scholarship in Optical Engineering was established in 1985 to honor Bill Price, who was a well-respected member of our technical community. The first award of the scholarship will be $4,000, to be announced in June 1987. The following requirements apply to the scholarship:

- The scholarship is to be awarded to a full-time undergraduate or graduate student studying optical design and engineering.
- Candidates should submit a 3–5 page technical paper in the area of optical design and engineering related to their interests and/or work at the college or university.
- The paper, along with the application form, should be sent by April 1, 1987, to

William H. Price Scholarship in Optical Engineering
c/o SPIE—The International Society for Optical Engineering
P.O. Box 10
Bellingham, WA 98227-0010.

For further information and/application forms contact Robert E. Fischer at 805/373-1970 or Margie Price at 818/899-1078.

Contributions to the scholarship can be sent to the above address.